

S A F E T Y
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E X P L O S I V E S A N D A M M U N I T I O N S

P R E S E N T E D B Y
S H R I S . K . S H I V L I H A , I O F S .
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A C K N O W L E D G E M E N T .

The author of this paper thanks the Convenor and the Organisers of this Safety Seminar for giving him an opportunity to share his views with the prominent safety professionals attending this seminar.

The author also thanks the Convenor and the Organisers in extending facilities (one of the facilities amongst so many) to present this paper to the august audience.

INTRODUCTION.

It was with a justifiable amount of pleasure that I accepted the invitation to participate in this seminar on explosives safety. I consider Seminars as excellent forum for free exchange of information and ideas and hope the discussions which are going to take place in this seminar will include many interesting topics and provide stimulating and informative material in achievement of safety in dealing with explosives and ammunitions.

The basic idea to discuss explosive safety is to seek possible solutions to problems in order to improve safety and reduce accidents involving explosives to an absolute minimum. For this, I consider that identification of problem areas plays a vital role and then to seek solutions to these problems or atleast to form the basis for further thought and study for developing new methods and approaches to eliminate the possible hazardous situations. Explosives are fraught with risk and every effort has therefore to be made to eliminate or to minimise such risk by adoption of all possible safety measures by way of choice of most suitable materials, manufacturing processes and techniques, mode of packing, handling, determining suitable storage conditions and safe mode of transportation. Explosive safety philosophy has undergone radical changes in the recent years. The main thrust is to formulate prescriptions which will afford maximum protection to personnel, sophisticated plants, equipments and specialised buildings in the vicinity of a "POTENTIAL EXPLOSION SITE". Armed Forces personnel and civilians engaged in the development, manufacture, storage and transportation of explosives and ammunitions are constantly exposed to the additional risk besides normal hazards of every day life. Judicious planning, better house-keeping and strict adherence to the regulations are the absolute necessity. The basic three elements of efficient Management in safety are (a) the sound safety programme (b) frequent visits to the sites for constant appraisal and in-depth analysis of problems and (c) good house keeping. The production worker or the soldier in the field does not have the information or the freedom to decide for himself whether a particular action is or is not dangerous to perform. The manufacturing items should have the clear concept of safety requirements and should seek no compromise on these and this is kept in view as the greatest responsibility in any hazardous

operation such as the production and the use of the explosives and the ammunitions.

GENERAL.

The history of accidents in the Explosives industry begins with man learnt the arts of their manufacture towards the end of the middle ages. Th lack of knowledge of the phenomenon that accompany the explosive ecomposition and perhaps the less respect that was given in these times to human life were the cause of large number of acidents and the seriousness of their consequences. In older days manufacturing workshops were located within the walls of the towns, often in pre-existing buildings. The safety precautions to prevent accidents were NIL. No allowance was made for the knowledge acquired from past accidents, the cause of hch was ascribed as the will of God. Only the Eighteenth century, after more and more, frequent and deadly explosions followed by fire, that destroyed entire blocks of cities, it was decided to transfer the manufacturing shops to outside the town. Th origin of explosion was generally caused by heat from Mechanical Parts of the Machine or fire lit by an imprudent worker. Safety measures were practised by people only in their individual capacity for self-preservation and defence out of fear of injury and no Organised Safety Programme was practised. From the early years of Nineth century till date though the mechanisation of industries has taken concrete shape in all the fields and disciplines, viz. chemical, engineering Metallurgy, Explosives etc. and a number of accidents were experienced in the early stage of change over, a concerted approach for effecting Safety measures on a scientific basis has been initiated by different Safety Organisations only recently.

In India concepts for Explosives Storage and Transportation and Processing o Explosives have attracted considerable attention of safety specialists since World War II. The U.K.Home office regulations on Qty - Distance were followed in earlier years but were subsequently replaced by Magazine regulations of 1934. During the years 1946 and 1947 the ESTC London staged a series of trials with large Qty.of High

Explosives and Propellants in U.K, Germany and Canada. The revised qty. distance was formulated and were adopted by ESTC(UK) in 1948. STEC in India decided to adopt these tables in 1949. The revised tables introduced the concept of process qty - distance for process buildings which are greater than those for storage buildings to provide a reasonable degree of safety to operators working in such buildings. The process qty.distance is set at 1.5 RB and the outside qty,.distance at 4 RB,. where RB is radius of the circle of B Damage i.e. such severe damage due to explosion that the structure necessitates demolition.The storage qty distance for propellants and bulk high explosives are based on Flame Radius. In the light of recent knowledge and experience, we have, now in India, been able to,lay down Qty.distance prescriptions and have extended major efforts in aiming at providing maximum protection to the personnel ,Plant/machinery and buildings as well as reducing costs of constructing new explosive facilities. For such purpose, careful consideration of the provisions of the revised safety distance regulations is being paid and emphasis is given that these are observed strictly while planning new factories or when erecting new buildings in existing factories. Special consideration is however given in regard to qty distance for siting of utilities of different nature. Greater Distance ensures safety in that in the event of an accidental explosion there should not be any chain process which can immobilise the entire factory while by itself it cannot stop any accident. Such a measure is also adopted by provision of Traverses. Explosives and ammunitions belonging to higher hazard division like HD 1.1 which are susceptible to explosion en-masse and have effects of blast, flame high speed fragments and debris are stored and processed in buildings provided with traverses.

A traverse is a solid mass of earth, sand or is made of brick, concrete and built around a building or stack containing explosives and their main functions are to protect explosives/personnel in nearby building or in the vicinity of explosives buildings by way of intercepting Low angle High velocity missiles generated by an explosion and stop them from causing direct propagation of Explosion /fire to adjacent buildings

holding explosives. There are various types and classification of traverses and designed based on opinion of many experienced personnel in the field and accepted all over the Globe. In India, the same norms are dopted and traverses as found suitable to our requirements considering from view point of both safety and economy, are constructed as a compulsory requirement.

Further, it will not be superfluous to mention here that there are various types of Explosives in use which present different characteristics and were classified according to their nature, characteristics etc. The erstwhile classification was mainly on the U.K.pattern wherein they were classified under 14 distinct Explosive group. This system of classification suffers from many shortcomings and inconsistencies viz. in some cases items which have very little in common were included in the same group and certain items which are having the same characteristics were placed in two or more groups. Though this system of classification is in vogue over quite number of years, no attempt was made to rationalise it on a scientific basis till the work was taken up by the U.N.Committee of experts, most of the countries are in the process of adopting or have adopted the UN classification system of explosives for the purposes of safety in storage, transport and fire fighting. India is also not trailing behind. To keep pace with the above and to achieve better safety, the new scientific system based on UN Classification has been adopted in a phased mannrad work executed in our explosive installations in this safer and scientific based system.

As far as Safety with Explosives, whether in the manufacturing process or filling of explosives or assembly of various filled components to various types of ammunition are concerned, great care is needed to be exercised. One question immediately comes to mind as to what really contributes to safety in explosives processing and handling. Generally speaking , it is the sum total effect on 3 Ms that is Man, Material and Machine and if the accidents are to be avoided , we must have good combination of the above. In addition, in the event of an unhappy accident resulting in an explosion every effort is to be made to localise the effect so that the devastation does not spread to a wide area dislocating other important facilities or causing injuries to personnel not directly connected to it. They

have also an effect on the society and building up morale at the same time besides loss of valuable time and production, restoring to normalcy in production, expenditure by way of compensation, medical treatment and so on. As the Explosive Industry itself is of specialised nature in which safety is of prime consideration, the M s occupy a special position. So far as personnel are concerned, the No.of industries in this field being limited, available trained personnel are only handful and nation cannot afford frequent loss of such trained personnel. Other Junior staff members with requisite technical background are to be trained and placed in position to shoulder responsibility in due course.

Raw materials constitute another source of danger in an explosive industry where apart from quality of finished products, safety in processing plays a very important role. Proper quality control of raw materials is n essential pre-requisite if accidents are to be avoided i.e. the raw materails must be required to the correct specification.

As far as the machineries, equipments, vessels etc. are concerned, the material of construction of these must be compatible with the chemicals/explosives to be used in them. Use of moving machineries particularly, metallic parts which come in tact with explosive materials have undergone a radical transformation over the last few decades. While in the past lead as a material of construction of vessels etc. and air as an agitating medium have ruled over this area for a long time. Slowly they have given way to the use of Stainless steel and other non-ferrous metals and alloys like aluminium , brass or Bronze and plastics for fabrication of plant items and positive mechanical devices for agitation or mixing. It has now been accepted that materials being used in contact with explosives should be sufficiently resistant to corrosion, tough and amenable to high polish so that where in use the surfaces offer the least resistance and friction. Amongst various other factors which are responsible for causn accidents in manufacture and handling of explosive chemicals, the hazard factor is the most dominating one. As varying in degrees all chemical explosives are hazardous from the stand point of their sensitivity to impact, friction, static electricity, spark and ignition. While hazard controlling measures for some of such chemicals are the control of temperature by way of air-conditioning ,humidity control, bonding and earthing of work benches, machines etc., application of modern

technology through instrumentation and automation has as well had desired effects of safe operation. However, inspite of great advantage of modernisation from the standpoint of quality and safety, some associated disadvantages are also there which if not looked into properly can paradoxically lead to major problems/accidents. Hence appropriate plant design and operations need greater stress and these should include preventive measures by having proper in-built safety as well as curative measures like isolation, remote control etc. Apart from what has been said, preventive measures through control of specific unsafe conditions and unsafe conditions and unsafe acts by men in the plant depending on the process and properties of explosives are also to be looked into. Such care and installation of modern safety gadgets give enough confidence to the working personnel. However, poor maintenance and workmanship in the handling of various gadgets can also cause accidents, sometimes bringing more misery than what could have otherwise been avoided in a corresponding conventional plant.

Use of electrical power is another area where considerable development has taken place. In earlier days electrification of rooms etc. where handling or processing of explosives is carried out is used to be discouraged and lighting was arranged from outside. This restriction necessiated all the activities to be conducted during day light hours. Electric sparking from appliances used to be regarded as potent source of danger in an explosive area but with the development of proper type of electrical appliances which do not allow either any spark to come out or any explosive or inflammable vapour to enter the appliances or which do not get overheated during continuous heat, the threat is reduced considerably. Positioning of approved electrical equipments including lighting fixtures within an explosive area has been quite common and safe in handling explosives. Periodical checking of lightning protection system, insulation resistance, earthing continuity etc. serve a gret deal in safe handling of explosives in a building.

Besides, it had added to our experience that the packages of explosives/ammunitions play a great role in their proper preservation as well as transportation from one place to the other. If they are not properly developed, mishandling and consequent premature functioning etc. may take place causing injury/damage and devastation. Tremendous research has been done by Indian

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experts in this regard and new designs in packages have been made which renders a great coverage of safety in transportation and prevents them in coming in contact directly with moisture, sunlight, heat and sparks of fire and static charges. Owing to the explosives being very sensitive as well as powerful, very stringent and significant regulations have been drawn for their transportation and restrictions imposed for mixing of different items and on the qty, speed of vehicles, type of vehicles and such other factors. Over the conventional explosive vans, specially developed carriages have now been in use for rockets, etc. which move on national highways to too long distances and in India we have been able to do so this very successfully with the safe requirements suiting to the wide range of weather conditions prevailing at one zone or other.

Lastly, I should add that disposal action of unserviceable or rejected explosives and ammunition demand a great attention. Regular disposal of the same in their proper way should never be neglected. They are the potential source of hazard. Any disregard or negligence will surely lead to unthinkable consequences. We have in our organisation, in every installation, our own disposal ground where these are disposed off by burning or treatment with suitable chemicals. We have designed our appliances for disposal of detonators, caps and other filled components and thus stepped forward in achieving safety in shop floors and in the entire installation as a whole.

In conclusion, I may add that safety is more like a welfare activity associated with personnel and the organisation. There should not be any compromise on safety. No deviation from safe norms and regulations should be allowed. Work must be performed in their proper layout under strict inspection and supervision and as necessary the process and other activities shall be reviewed at regular intervals and updated in line with the advance made in the field and safety information disseminated to all through all media as would be available. I shall conclude by uttering that 'safety is directly connected to progress'.

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